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IRREVERSIBLE DIFFERENTIATION AND ORTHOGENESIS

THE publication in 1919 of the three noble volumes of posthumous works of the late Professor Whitman[1] redirects our attention to the problem of orthogenetic evolution. The evidence here presented may be regarded as demonstrative that in pigeons variations do not occur in all cases at random around fixed modes as unit characters in accordance with the laws of probability, but that they tend to appear in the course of phylogeny in an irreversible series.

Numerous other students of evolution have formulated similar conceptions under the names, orthogenesis, orthoplasy, directive evolution, etc., some of which are referred to by Whitman, and others are cited at length by Baldwin in his book on "Development and Evolution" (New York, 1902). Most of these statements leave much to be desired from the scientific standpoint and they frequently lead to the expressed or implied postulation of metaphysical factors.[2] Nägeli's principle of perfection is of this sort and has not been especially fruitful. Others, like Eimer,[3] though basing their conclusions on extensive critical observation, have allowed themselves to be swept along by controversial

[1] "Orthogenetic Evolution in Pigeons." Posthumous Works of Charles Otis Whitman. Edited by Oscar Riddle. Published by the Carnegie Institution of Washington, 1919.

[2] The term orthogenesis has been applied in a great variety of senses, some of them decidedly mystical. These are summarized by Vernon L. Kellogg in "Darwinism To-day," New York, 1907, pp. 274–288.

[3] Eimer's Leyden address published by The Open Court Publishing Co., Chicago, 1898, under the title, "On Orthogenesis and the Impotence of Natural Selection in Species-Formation," gives a summary of his views with citation of the original sources of his data.

currents beyond the safe haven of calm and well-considered evaluation of all factors in the problem.

Competent naturalists of wide experience in many scientific fields are, however, continually bringing forth new confirmatory evidence that the direction of the evolutionary process is to some extent and in some way determined from within and that the course of differentiation of organic forms is not in its entirety directly and passively shaped by the environmental mold. That these internal factors are ultimately to be referred to the reaction between the living substance and its environment was clearly recognized by Eimer, as is shown by the following quotation:[4]

> In my view development can take place in only a few directions because the constitution, the material composition of the body, necessarily determines such directions and prevents indiscriminate modification. But through the agency of outward influences the constitution must gradually get changed. The organisms will thus acquire more and more physiological individuality and respond to outward influences more and more in a manner harmonizing with their specific individuality—and so new directions of development will be produced.

Eimer's further contention that this conception implies the unqualified acceptance of the inheritance of acquired characters has doubtless been an obstacle to the more general approval of his views. To this point we shall return.

As the currents of thought regarding the truth of evolution in general drifted more or less impotently in a sea of speculation until Lamarck, Darwin, DeVries and others confined it within scientifically definable banks by presenting plausible explanations of the possible mechanism of the process, so orthogenesis has remained an ill-defined and at times quasi-mystical hypothesis as long as we had no comprehensible account of the causative factors which may direct the course of future differentiation. It may be regarded as established that orthogenesis in some form is an evolutionary factor. But what of the method?

Child[5] has laid down some general principles which point the way in this inquiry. Undifferentiated tissues with active metabolism (termed tissues of the "young" type by Child) contrast sharply with the more stable and mature tissues whose protoplasm has assumed characteristic structural patterns in adaptation to specific functions (muscle, gland, etc.). The tissue patterns of the latter group not only maintain their individuality during the life of the organism, but their stability extends deeper into the hereditary organization of the species and their characteristic forms run true in successive generations. There is accordingly, as Child expresses it, a secular change in the character of protoplasmic organization in the direction of a fixation or stabilization of the more labile and metabolically active tissues of the embryonic or generalized type into more highly specialized and stable patterns. This process of evolution of form is, of course, concomitant with a differentiation and fixation of heritable behavior patterns.

The general physiological processes involved here have been analyzed by Child and the underlying physico-chemical apparatus has been experimentally studied in an illuminating series of researches on bio-electric phenomena and their inorganic analogies by R. S. Lillie.[6]

This process of progressive maturing of tissue in the course of evolution is not different in fundamental biological character from that seen in the course of ontogenetic development, and both are expressions of more efficient adjustment of the living substance to

[5] "Senescence and Rejuvenescence," Chicago, 1915.

[4] *Loc. cit.*, p. 22

[6] "Transmission of Activation in Passive Metals as a Model of the Protoplasmic or Nervous Type of Transmission," Science, N. S., Vol. 48, 1918, pp. 51–60. "Heredity from the Physico-chemical Point of View," *Biol. Bul.*, Vol. 34, 1918, pp. 65–90. "Nervous and Other Forms of Protoplasmic Transmission," *Sci. Mo.*, Vol. 8, 1919, pp. 456–474, 552–567. "Precipitation Structures Simulating Organic Growth. II. A Contribution to the Physico-chemical Analysis of Growth and Heredity," *Biol. Bul.*, Vol. 36, 1919, pp. 225–273.

the manifold diversities of the environment, that is, in the wide view they are adaptive. Natural selection may (or may not) act upon the products of this differentiation as they are formed. Inheritance of acquired characters in the ordinary sense of this expression is not implied here, though some recasting of current ideas of the individuality of the germ plasm and the nature of the mechanism of heredity is a necessary consequence of the recent studies in general protoplasmic physiology to which reference has been made.

Now this process of senescence of tissue is to a large extent reversible; that is, a specialized tissue may dedifferentiate and return to the embryonic type, as happens in the ordinary processes of reproduction, regeneration and the like. But this capacity for dedifferentiation is not universal, nor where it occurs is it always accomplished with equal facility. In general, specialized tissues return to the undifferentiated condition with greater difficulty than do the simpler and more generalized kinds and the capacity for form regulation diminishes *pari passu* with the increase in complexity of bodily organization. In higher organisms groups of general body cells are incapable of reproducing the whole body as in lower forms; in a salamander an entire limb can be regenerated, but in a man this is impossible; and differentiated nerve cells are incapable even of cell division. To this extent, tissue differentiation is irreversible.

This progressive stabilization of heritable patterns of organization is an essential factor in evolution, and to the extent that these patterns are irreversible the future course of evolution is predetermined. For, given a particular inherited structural pattern, variations will be distributed around this as a mode is accordance with a different frequency curve than would be shown if the inherited pattern were different; and the same applies to mutations..[7]

An aquatic species which has acquired adaptation to life on land has established new modes around which its variations and mutations are distributed. True, it may in time return to the water, though never in a higher animal by the process of dedifferentiation to the original aquatic form but only along lines of further differentiation derived from and congruous with its established terrestrial patterns.

Again, with the establishment of the ladder type of central nervous system as seen in annelid worms, a stable pattern was laid down with certain functional capacities. On the other hand, with the establishment of the tubular type of central nervous systems in early vertebrate ancestors, a different pattern was fabricated with its own characteristic correlated behavior. On the basis of each of these matured and stabilized tissue differentiations a wide variety of central nervous systems has been derived—from the annelid type the whole series of arthropods and from the protochordate type the whole series of vertebrates. But throughout each of these phyla the fundamental pattern has not been changed, nor have we any adequate evidence that one has ever been transformed into the other.

In other words, from the time when these two structural patterns were first established and stabilized, the process was irreversible; the tissues concerned have in this respect and to this extent passed from the "young" or labile state to the "mature" or rigidly determined form. The undifferentiated type antecedent to both of these phyla was labile in the sense that under appropriate conditions it could differentiate in either direction; but having passed over to either one of the differentiated forms, it has apparently lost its capacity to transform to the other type, either by dedifferentiation and remodelling of its pattern or by any other method. At any rate we have no convincing evidence that this has been done. In short, the whole future course of evolution of the vertebrate phylum was set in a different direction from that of the arthropods from the first appearance of a neural tube.

[7] Metcalf, M. M., "Adaptation through Natural Selection and Orthogenesis," *Am. Nat.*, Vol. 47, 1913, pp. 65–71.

The insects comprise the highest invertebrates and as a group they are remarkably efficient animals; but their extremely diverse specialization is spread out on a rather low plane and the behavior of each individual member of the group is tolerably rigidly limited to a narrow range of instinctive acts with small capacity for individual modifiability. The extreme plasticity of the group of ants as a whole, so graphically portrayed by Wheeler,[8] has been biologically determined through natural selection or otherwise by the adaptation of each of the diverse species and castes for a very special mode of life which must be followed through, with no considerable deviation. This is in sharp contrast with the plasticity of the higher mammals which rests rather on capacity for modifiability, docility and intelligent adaptation to new conditions of each individual animal.

Similarly, within the vertebrate phylum we find divergent modifications of the primary tubular pattern of the central nervous system, each of which, as soon as matured and stabilized in the inherited organization, favors subsequent differentiation in certain directions and precludes it in others, for this differentiation is irreversible.

The teleostean type of forebrain is quite unlike anything else in nature. It probably was early forecast in primitive ganoids with brains like those of the modern sturgeons, where there is no evagination of the cerebral hemispheres but instead local thickenings in the unevaginated walls of the rostral portion of the neural tube. Once this method of differentiation was established, there is no evidence that it ever gave rise to the type represented by Amphibia and all Amniota with hollow hemispheres. The teleosts, like the insects, are very efficient organisms and in the aggregate they adjust to a wide variety of conditions, but they are differentiated on a relatively low plane, the structural and behavior patterns of each species are rigid and narrowly circumscribed, and the group has given rise to none of the higher types.

In the primitive reptilian stock there was another divergence in pattern of forebrain evolution. One type developed masive basal nuclei in the cerebral hemispheres, as in modern saurians. This line of differentiation advanced to culminate in modern birds with basal nuclei (striatum complex) more massive than in any other animals and with very insignificant cerebral cortex. In correlation with this, the birds on the behavior side present the culmination of instinct, with intelligence of low order. A second reptilian type, starting with brain forms more like those of the modern turtles, followed a different line of differentiation and led up to the mammalian type with wide lateral ventricles and extensive superficial cerebral cortex. This type seems better adapted to develop into an adequate organ of intelligent behavior, and in this direction it appears not yet to have reached its limit.

In speaking of the influence of the arboreal habitat upon the evolutionary history of Primates, F. Wood Jones,[9] draws an interesting contrast between this phylum and the arboreal marsupials (Metatheria), in the following passage:

> These arboreal Metatherians have had all the educational advantages of a thoroughly arboreal life; nothing that we have pictured has failed to exert its influences upon them, and yet it is obvious that the advantage that they have taken of it has been slight. There are metatherian convergent mimics of Carnivora, Rodentia, Insectivora, and of most other Eutherian orders, but there is no metatherian convergent mimic of the eutherian Primates. It would not be unnatural, therefore, to assume that the full advantage could not be grasped by the metatherian animals, since the ground-plan of their brain would not permit it.

The argument continues that the absence of the corpus callosum in Metatheria gives the clew to this orthogenetic limitation.

From these and innumerable similar instances familiar to every comparative anatomist it may be argued that the process of differentiation, so far as this represents an irreversible process, is itself a natural cause of limitation of the future course of evolution

[8] "Ants," New York, 1913.

[9] "Arboreal Man," London, 1916.

within the boundaries set by the efficient working of the established pattern.

Looking at the animal kingdom from the behavioristic side, most animal activities are compounded of two factors: (1) innate and heritable factors (reflexes, instincts, and the like), and (2) acquired modifications of the inherited patterns (culminating in docility and intelligence). In some animal phyla the first component is dominant, in others the second. And the differentiation of an apparatus adequate for a highly refined and very elaborate instinctive behavior complex may preclude the development of the more labile modifiable types, as appears to be the case in insects, higher fishes, and to a less extent birds. The structural patterns serving the higher intelligent types of behavior have not been evolved from those lower brains exhibiting highly differentiated and stabilized inherited patterns correlated with complex instincts, but rather from more generalized forms which have remained more plastic (from the evolutionary standpoint) because less of their material has passed on into the mature form of tissue.

The higher forms retain their dominant position and continue advance in this direction because parallel with the elaboration of their stable, heritable nervous and instinctive patterns they retain sufficient labile nervous tissues of the "young" and plastic type to enable each individual to make his own adaptations to a great variety of environmental conditions and to profit by this experience.

C. JUDSON HERRICK

THE UNIVERSITY OF CHICAGO

EDUCATIONAL INSTITUTIONS REPRESENTED IN THE MELLON INSTITUTE

> "It is not so much to know how to direct research men as it is to know where to find them."—*Old chemical proverb.*

AN inquiry which is received frequently by the administration of the Mellon Institute is, "Where do you obtain your research chemists?" It is a familiar truth that there is a serious scarcity of men of demonstrated research ability; and since, *ceteris paribus,* the institute adheres to the policy of starting new investigational work only as competent men are available, the question is, therefore, of scientific interest. It can not, however, be answered except with certain conditional stipulations. In the first place, there is a diversity of opinion as to the basic qualifications for research, and particularly for industrial research. Then, there is the requisite of considering the exact nature of the investigation and the definite type of researcher needed therefore. And, finally, there must be borne in mind the fact that the finding of every research man is attended with difficulty because it frequently involves the gift of prophecy on the part of the searcher—or, at least, the application of a proleptic study which is at present in an inchoate condition. The supply of men capable of working at high efficiency as scientific investigators has been, and probably always will be, well below the demand; and scientists having the requisites and spirit of the researcher are, indeed, difficult to find even by ones widely experienced in the direction of research. Perhaps the most effective instrument for the recognition of investigational keenness is the comparative method, but the study of its use is still in its infancy.

On account of the extraordinary importance of new ideas, particular emphasis should always be laid upon locating and supporting brilliant investigators. Such individuals can best be found in the universities, although it should be the ambition of every research director to attract, rather than to seek, qualified scientific investigators. The function of the university is to operate with the beneficent idea of increasing the sum of human knowledge, and among its most valuable products are those young men of initiative who will work for the exercise of the investigative instinct and the pleasure of overcoming difficulties. Dr. Robert Kennedy Duncan once said:

That "good men" are scarce is, of course, a truism; but it is terribly apposite in these days. The modern manufacturer advisedly economizes in everything but salaries, and the very considerable salaries paid to "good men" are ample evidence of their rarity. Now, the purlieus of adolescent "good men" are the laboratories of the university. There it is that men are "tried out," and there it is, too, that men are known better than they know themselves.

Supporters of scientific and industrial research must aid in helping to establish a condition which will ensure a greater number of scientific teachers who are also trained as productive scientists. It can not be gainsaid that it is a highly desirable plan to arrange curricula so that every teacher whose favorite pursuit is research may develop it by the assistance of his students. The most important problem in industrial research today is not, how shall use be made of trained scientific investigators? It is, rather, how may there be produced annually active young students of science at a greater rate and of higher quality? And in this connection, thought must be expressed in terms of thousands per year of the type of trained men represented, say, by the doctor's degree or by two or more years of individual experimental work following the completion of appropriate undergraduate training.

The following list presents the institutional source of the incumbents of the Industrial Fellowships of the Mellon Institute from the time of its foundation in 1912 to the present day. It is the experience of the administration of the institute that a knowledge of the domestic history of the important research-schools facilitates the prognosis of the investigational possibilities of applicants therefrom. This information also renders less difficult the occasional quests for experts or research men possessing specific qualifications of a high order. Every large industrial research laboratory whose operation discloses telesis has received innumerable benefits from the establishment of cordial relations of cooperation with the various researchful university laboratories.

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Westminster College	1		
Wooster College	2		
Yale University	2	1	6

W. A. HAMOR

MELLON INSTITUTE OF INDUSTRIAL RESEARCH,
UNIVERSITY OF PITTSBURGH,
April 1, 1920

SCIENTIFIC EVENTS

THE CARDIFF MEETING OF THE BRITISH ASSOCIATION

ACCORDING to an article in the London *Times* the arrangements for the 1920 meeting of the British Association, which opens at Cardiff on August 24, are well advanced. The inaugural meeting will be held in the Park Hall on the evening of the opening day, when Professor W. A. Herdman, ex-general secretary, will assume the presidency in succession to Sir Charles Parsons.

Professor Herdman in his presidential address will give a general survey of the subject of oceanography, dealing in detail with certain special problems and recent investigations with particular reference to sea fisheries. On Thursday evening, August 26, an address will be delivered by Sir Richard T. Glazebrook, who recently retired from the post of Director of the National Physical Laboratory. The subject has not yet been fixed. The second evening discourse is to be delivered by Sir Daniel Hall, permanent secretary of the Board of Agriculture since 1917, whose subject will be "A grain of wheat from the field to the table."

The president of the mathematical and physical science section will be Professor A. S. Eddington, who recently came prominently before the public as a leading protagonist in the discussion on the Einstein theory of relativity. Dr. F. A. Bather is to be the president of the geological section, and his address will discuss the general problems of paleontology, especially in their relation to zoology. The presidents of the other sections, the subjects of whose addresses are not yet fixed are: Zoology, Professor J. S. Gardiner; geography, Mr. J. McFarlane; economics, Dr. J. H. Clapham; engineering, Professor C. F. Jenkin; anthropology, Professor Karl Pearson; physiology, Mr. J. Barcroft; botany, Miss E. R. Saunders; education, Sir Robert Blair; and agriculture, Professor F. W. Keeble.

The citizens' lectures, which developed out of the single lecture which used to be given to the operative classes of the towns visited by the association, are now arranged in collaboration with the local branch of the Workers' Educational Association. The lecturers this year will be Professor Boulton, of Birmingham, Professor Lloyd Williams, of Aberystwyth, Professor A. W. Kirkaldy, of Nottingham, and Dr. Vaughn Cornish. The president of the Conference of Delegates of Corresponding Societies will be Mr. T. Sheppard, curator of the Municipal Museums at Hull.

THE ENGLISH DEEP-SEA FISHERIES

A SPECIAL correspondent of the London *Times* who has visited some of the chief fish-

ing ports of the country has shown in a series of articles that trawler owners are losing money owing to the low prices realized for the catches of their boats.

The difficulties of the industry appear to be due to the greatly increased cost of labor, coal, gear and repairs, to the very large quantities of fish recently landed, and to the lack of facilities for transporting fish from the ports to the inland markets. Working costs can not easily be reduced under existing conditions, and the only remedy for the situation would seem to lie in better distribution and an increase in the consumption of fish. The help of the government is sought to improve the means of distribution, but the trawler owners complain that the government takes no interest in deep-sea fishing as an industry.

The view taken by the National Sea Fisheries Association is that more would be done for the fisheries if the ministry of agriculture and fisheries were organized in two divisions, each with its own secretariat and each with its own vote. The association suggests that a fisheries division of the ministry should be developed, with three branches, dealing respectively, with administrative, executive and research affairs, and that the functions to be distributed among these branches should include the administration of the fisheries vote, the promotion of fisheries legislation, matters relating to international fishery conventions or agreements, executive work bearing on the catching, preparation, marketing, and distribution of fish, and researches into the natural history of fish and their treatment as food after capture.

A further proposal is that England and Wales should be divided into seven fishery areas, and that each area should be in charge of a commissioner of fisheries with a staff of inspectors and fishery officers sufficient to enable him to deal with all problems of catching and the distribution of fish in his jurisdiction. Each commissioner would act as the connecting link between the government and the industry, between capital and labor within the industry, and between the producer and the distributor. The staff, it is proposed, should give assistance in matters affecting the safe dispatch, transport, and delivery of fish from port to market at reasonable rates, in improving conditions at existing markets and inaugurating new markets, in the daily telegraphic publication of wholesale prices at port and market, and in the improvement of fast lateral railway traffic for the carriage of fish from the coasts to the main centers of population.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

The National Exposition of Chemical Industries returns to the Grand Central Palace in New York, where it will be given during the week of September 20 to 25, 1920, inclusive. *The Journal of Industrial Chemistry* states that this year's exposition will be the largest distinctly industrial exposition ever held. In 1915 the first exposition was composed of 83 exhibitors, the second increased to 188, the third to 288, the fourth to 334, and the fifth, in which the available space was much restricted and exhibitors were held to a minimum, admitted 351 exhibitors. The present number of 358 can not be much increased because of the limited amount of space remaining. Another floor has been added, giving four floors of the Grand Central Palace, each of which covers a city block. To the first exposition there came 63,000 visitors, to the second 80,000, and this has steadily increased till at the last the attendance exceeded 111,000.

This year there will be three special sections: the Electric Furnace, the Fuel Economy and the Materials Handling Section. The two latter are new sections. The first will, as its name implies, be one of electric furnace exhibits; the Fuel Economy Section will consist of exhibits of machinery and apparatus, furnaces, producers, stokers and all devices for the economic utilization or more efficient combustion of fuel. The possible exhaustion of our fuel reserves in the not far distant future and the present high cost of fuel make this section one of much interest to all industrial plants. The Materials Handling Section will be a series of exhibits of machinery and equipment for the handling of material, such as

conveying, transporting, elevating, and included in this will be weighing, measuring and power transmission equipment. So important have these mechanical features become for all industrial plants due to the shortage and high wage for man power that an unusual interest is expected in this new section.

The program for the exposition will have session on subjects the phases of which will be developed in the exhibits of these latter two sections. There will be sessions on chemical engineering for which an elaborate program is planned. Motion pictures which will have an interest for mechanical men will form part of the program, and there will be popular public addresses as well.

THE WORK OF THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS

THE National Committee on Mathematical Requirements held a meeting in Chicago on April 23 and 24. The principal topic discussed at this meeting was the preliminary report on "Junior High School Mathematics" prepared for the committee by Mr. J. A. Foberg. After detailed discussion and some amendment and revision, the report was adopted by the committee and its publication as a preliminary report authorized. It has been submitted to the U. S. Bureau of Education for publication as one of its secondary school circulars.

Reports of progress were made by subcommittees on the training of teachers, experimental schools and courses, disciplinary values and transfer of training, elective courses in mathematics for high schools, and mental tests. It is expected that preliminary reports on all of these topics will be ready for consideration by the committee at its next meeting on September 2, 3 and 4. The attention of experimental schools throughout the country is called to the report on this subject being prepared for the committee by Mr. Raleigh Schorling of the Lincoln School, New York City. Any experimental school or schools giving experimental courses in mathematics who desire to be represented in this report should communicate with Mr. Schorling without delay, if they have not already done so. A subcommittee on the standardization of terminology and symbolism, with Professor D. E. Smith as chairman, and a subcommittee on junior college mathematics, with Mr. A. C. Olney as chairman, were appointed. J. W. Young, Raleigh Schorling and W. F. Downey were authorized to take steps to initiate investigations into the mathematical elements entering into various industries, professions, vocations, etc.

A budget for the coming year based on the recent appropriation of the General Education Board of $25,000 for the use of the committee in completing its work was adopted. It is hoped that the increase in the item allowed for traveling expenses in this budget will make it possible for representatives of the committee to reach educational meetings in all sections of the country where such representatives are desired to discuss the various reports of the committee. Nearly 70 organizations are at present actively cooperating with the committee and it is hoped that many others will communicate with the chairman in the interest of furthering the nation-wide study and discussion which is already underway. J. W. Young, 24 Musgrove Building, Hanover, N. H., and J. A. Forbeg, 3829 North Tripp Avenue, Chicago, Ill., were re-elected chairman and vice-chairman, respectively, of the committee for the ensuing year.

J. W. YOUNG,
Chairman

THE ELLIOT MEDAL IN ZOOLOGY AND PALEONTOLOGY

TERMS of the award of the Daniel Giraud Elliot Medal for zoology are written in the deed of gift to the National Academy of Sciences as follows:

> One such medal and diploma shall be given in each year and they, with any unexpected balance of income for the year, shall be awarded by the said National Academy of Sciences to the author of such paper, essay or other work upon some branch of zoology or paleontology published during the year as in the opinion of the persons, or a majority of the persons, hereinafter appointed to be the judges in that regard, shall be the most

meritorious and worthy of honor. The medal and diploma and surplus income shall not, however, for more than two years successively, be awarded for treatises upon any one branch of either of the sciences above mentioned. Professor Henry Fairfield Osborn, of New York, the scientific director of the American Museum of Natural History in New York City and the secretary of the Smithsonian Institution at Washington for the time being, are appointed as such judges. Vacancies at any time occurring in the number of the judges shall be filled by the Council of the said National Academy of Sciences, and in each case of a vacancy it is the wish of the said Margaret Henderson Elliot that the council will, if practicable, appoint to the position an American naturalist eminent in zoology or paleontology.

As science is not national the medal and diploma and surplus income may be conferred upon naturalists of any country, and as men eminent in their respective lines of scientific research will act as judges, it is the wish of the said Margaret Henderson Elliot that no person acting as such judge shall be deemed on that account ineligible to receive this annual gift, and the medal, diploma and surplus income may in any year be awarded to any one of the judges, if, in the opinion of his associates, he shall, by reason of the excellence of any treatise published by him during the year, be entitled to receive them.

The committee of the award includes Secretary Charles D. Walcott, of the Smithsonian Institution; Director F. A. Lucas, of the American Museum, and President Henry Fairfield Osborn, of the American Museum. The committee invites nominations from the works of the year 1919. The award for 1917 was to Frank M. Chapman's "Birds of Colombia." The award for 1918 was to Beebe's "Monograph of the Pheasants."

Henry Fairfield Osborn
American Museum of Natural History,
New York

SCIENTIFIC NOTES AND NEWS

Princeton University has conferred its doctorate of laws on Dr. Raphael Pumpelly, the geologist, and its doctorate of science on Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research. Dr. Carrel has also received the same degree from Brown University.

The degree of doctor of science was conferred upon Dr. Frank Schlesinger, director of the Yale Observatory, by the University of Pittsburgh at its commencement on June 9.

The degree of doctor of science was conferred on Professor Lewis William Fetzer, of the department of physiology and pharmacology in the Baylor University College of Medicine, at the recent commencement exercises of the University of Dallas.

The degree of doctor of laws has been conferred by the University of Pennsylvania on Professor John M. Macfarlane, who is this year retiring from the chair of botany after a service of twenty-eight years.

The degree of doctor of science has been conferred by the University of Liverpool on Professor F. G. Donnan, formerly professor of physical chemistry in the university, and now professor of chemistry in University College, London, and on Professor W. A. Herdman, formerly Derby professor of natural history, and now professor of oceanography, in the university.

The honorary degree of doctor of letters has been conferred by the University of Oxford on Dr. Temistocle Zammit, professor of chemistry in the University of Malta and curator of the Valetta Museum.

Dr. B. L. Robinson, Asa Gray professor of systematic botany in Harvard University, has been elected a corresponding member of the Czecho-Slovakian Botanical Society.

The Stewart prize of the British Medical Association has been awarded to Dr. Harriette Chick, an assistant in the department of experimental pathology of the Lister Institute.

Sir William J. Pope has been elected president of the Society of Chemical Industry.

Professor Augustus Trowbridge, of the department of physics of Princeton University, has been granted a leave of absence for the coming academic year in order to become chairman of the Committee on Mathematics, Physics and Astronomy of the National Research Council.

HENRY L. WARD, for the past eighteen years director of the Public Museum of the city of Milwaukee, has tendered his resignation to become effective on or before January 1, 1921.

ALEXANDER L. PRINCE, M.D., assistant professor of physiology in Yale University Medical School, has resigned in order to accept a position in the industrial research department of the Ætna Life Insurance Company at Hartford.

DR. ALFRED N. COOK, for sixteen years professor of chemistry at the State University of South Dakota and for thirty-nine years a teacher of chemistry, has resigned to take effect at the close of the present academic year. He will make his future home in southern California.

DR. A. NEIVA, chief of the public health service of the state of S. Paulo, Brazil, has been commissioned by the authorities to study the organization of the public health service in Japan and in the United States, and the prophylaxis of leprosy in Norway, the Philippines and Hawaii.

PROFESSOR EDMUND HARVEY, of Princeton University, has received leave for the first term of next year, during which he will join a scientific mission to the East Indies for the Carnegie Institution to study animal luminescence.

DR. FRANK E. LUTZ, of the American Museum of Natural History, of New York City, has started on the third of a series of expeditions planned to trace the distribution of insect life in the western part of the United States. The first of these expeditions collected in the Santa Catalina Mountains and the deserts of Southern Arizona; the second—made last year—worked in the Colorado Rockies. This year special attention will be paid to regions north and west of Colorado.

MR. E. P. VAN DUZEE, curator of entomology in the California Academy of Sciences, and Dr. E. C. Van Dyke, of the University of California, who attended the annual meeting of the Pacific Division of the American Association for the Advancement of Science in Seattle, will remain for a month in the state of Washington for field work. Mr. Van Duzee, who specializes in the Hemiptera, has in his collection and that of the California Academy of Sciences probably the most representative collection of Hemiptera in America. Dr. Van Dyke will collect Coleoptera in which he is a specialist.

DIRECTOR HOMER R. DILL, of the Vertebrate Museum, State University of Iowa, is to accompany Mr. Ernest W. Brown on a fish collecting expedition to the Hawaiian Islands during the months of July and August. The specimens collected will be divided between Mr. Brown's private collection and the Iowa Museum. The first of September an expedition headed by Professor Dill will be sent to the Cascade Mountains in northeastern Washington and British Columbia for the purpose of studying the mountain goats in their native haunts and collecting specimens for museum exhibits. The State Museum of Washington will be represented by Curator C. J. Albrecht. Other members of the party are Mr. Robert Brown, Mr. Russell Hendee and Mr. B. E. Manville. Mr. Ernest Brown, of Des Moines, is assisting the undertaking by meeting a considerable part of the expense.

DR. LIBERTY HYDE BAILEY, of Ithaca, now president of the American Pomological Society, is reorganizing the society throughout the country, and is establishing junior branches in a number of agricultural colleges in the United States and Canada. The American Pomological Society, organized in 1847, is the oldest of our national agricultural societies. The society proposes under its new plan to consider national affairs which touch upon the growing of fruits, such as legislation, quarantine, export, transportation and standardizing of methods.

THE Imperial Entomological Conference was opened in London on Tuesday, June 1, by Lord Harcourt. We learn from *Nature* that the official delegates to the conference are: Canada and South Africa, Mr. C. P. Lounsbury; Australia, Professor R. D. Watt; New

Zealand, Dr. R. J. Tillyard; India, Mr. C. F. C. Beeson; Queensland, Mr. F. Balfour Browne; British Guiana, Mr. G. E. Bodkin; Ceylon, Mr. F. A. Stockdale; East Africa Protectorate, Mr. T. J. Anderson; Federated Malay States, Mr. P. B. Richards; Gold Coast, Mr. W. H. Patterson; Imperial Department of Agriculture for the West Indies and Leeward Islands, Mr. H. A. Ballou; Mauritius, Mr. G. G. Auchinleck; Northern Rhodesia, Dr. Aylmer May; Southern Rhodesia, Mr. R. W. Jack; Seychelles, Dr. J. B. Addison; Sierra Leone, Mr. H. Waterland; Straits Settlements, Mr. P. B. Richards; Sudan, Mr. H. H. King; Trinidad, Mr. F. W. Urich, and Uganda, Mr. C. C. Gowdey.

Professor C. E. McClung, head of the department of zoology in the University of Pennsylvania, national president of the Sigma Xi, and chairman of the section of biology and agriculture of the National Research Council, addressed the Michigan Chapter of the Sigma Xi at the annual initiation and banquet on June 3 on the "Relation of the Sigma Xi to the National Research Council." Professor E. C. Case, of the University of Michigan, gave a brief memorial of Samuel Wendell Williston.

Frenatæ, the Entomological Club of the University of Minnesota, holds regular meetings every Tuesday throughout the year, at 4:30 P.M. in the entomological laboratories, University Farm, St. Paul. During the summer special field trips will be arranged. Entomologists visiting the Twin cities are invited to attend and to take part in these meetings. Among the visitors and speakers of the past year have been: H. E. Ewing, of the National Museum; W. E. Dove, Bureau of Entomology; T. B. McGath, of the Mayo Institution; H. E. Strickland, of the Canadian Entomological Service; Professor H. L. Osborn, of Hamline University, and Professor Sadao Yoshida, of Osaka, Japan.

The death is announced of Mr. Henry Lindenkohl, cartographer of the U. S. Coast and Geodetic Survey, in his eighty-second year, after fifty-nine years of service with the Survey. Mr. Lindenkohl was born in Hesse-Cassell, Germany, and became an American citizen in 1861.

Dr. James Hervey Hyslop, secretary of the American Institute for Psychical Research, formerly professor of philosophy in Columbia University, died on June 17, in the sixty-sixth year of his age.

Dr. Frank Shipley Collins, who for many years has been recognized as one of the foremost American authorities upon the *Algæ*, died suddenly of heart disease at New Haven, Conn., on May 25, in his seventy-third year. Born on February 6, 1848, he was for the greater part of his life a resident of Malden, Mass., where he became an expert accountant in the employ of a large rubber manufacturing company. He early developed an interest in botany and was a leading spirit in the Middlesex Institute, a local scientific organization which did much creditable work, including the preparation of the Flora of Middlesex county, Mass., of which Mr. Collins was co-editor with the late Lorin L. Dame. In 1895 Mr. Collins was one of the founders of the New England Botanical Club, of which he was president from 1902 to 1905. In 1899 he became one of the associate editors of *Rhodora*, the journal of the club, a position that he held with distinguished ability until his death more than twenty-one years later. The greater part of his contributions to science relates to the marine algæ, on which group he published many papers. In association with Professor W. A. Setchell and the late Isaac Holden, he edited an extensive and highly valued series of algal *exsiccatæ*, the *Phycotheca Boreali-Americana*. In recognition of his excellent scientific work he was appointed associate of the Harvard University Museum, was elected a fellow of the American Academy of Arts and Sciences, and received the honorary degree of D.Sc. from Tufts College.

The following quotation is taken from the *Bulletin* of Wheaton College under the heading "Our new professors":

> Our former biology teacher because of a change in view or for some other reason was teaching the

doctrine that human beings have descended from animals. This not being the belief of the college, which accepts the Bible account of creation in all its details, she resigned her position and her resignation was accepted. God sent to us in a very definite manner Professor S. J. Bole, an A.B. from the University of Illinois, who was for nine years an instructor in the Illinois State University, but whose religious views were positive and clear and made him desirous of a change. He has entered upon his work with enthusiasm and is very highly esteemed by his fellow teachers and students. In view of the general situation among university men, we consider his coming to us distinctly providential.

THE Indian mathematician Srinivasa Ramanujan, F.R.S., fellow of Trinity College, Cambridge, has died at the age of thirty-two years.

THE death is announced at the age of seventy-seven years of Clement Arkadievitch Timiriazeff, emeritus professor of botany in the University of Moscow, recently elected to the Moscow soviet. Professor Timiriazeff was known for his work on the participation of the different rays of the visible spectrum in the photosynthetic activity of the green leaf. He was the author of a number of books on botany and agriculture, his earliest being a work on "Darwin and his Theory" published in 1863.

THE Biological Station of the University of Michigan will hold its twelfth session on the shores of Douglas Lake near Pellston in northern Michigan, June 28 to August 20, under the directorship of Professor George R. La Rue. The instructors are: Professor Frank Smith, University of Illinois; Assistant Professor Paul S. Welch, University of Michigan; Dr. Dayton Stoner, State University of Iowa; Assistant Professor Frank C. Gates, Kansas State Agricultural College; Assistant Professor George E. Nichols, Yale University; and Dr. John H. Ehlers, University of Michigan. Special and research courses in zoology and botany and facilities for research are also offered to qualified students.

THE summer courses in biology at the Hopkins Marine Station, Pacific Grove, California, began on June 22 and will end on September 3. Instruction is offered in general zoology, the classification and ecology of marine invertebrates, comparative anatomy of vertebrates; the fishes of California, elementary physiology, general physiology, the algæ and special work in zoology, physiology and botany. The faculty will consist of Professors W. K. Fisher, Edwin C. Starks, and Gertrude Van Wagenen in zoology; Professors E. G. Martin, J. P. Baumberger, and J. M. D. Olmsted in physiology and J. I. W. McMurphy in botany. Dr. Frank R. Lillie, of the University of Chicago, spent the winter quarter at the station and Dr. H. H. Newman is there during the spring quarter.

UNIVERSITY AND EDUCATIONAL

THE will of Richard M. Colgate gives $100,000 to Yale University and to Colgate University.

DRURY COLLEGE has completed the raising of $400,000 in order to secure an additional sum of $200,000 from the General Educational Board. The net productive endowment of the college is now over one million dollars. As a consequence of the success of this endowment, salaries of professors and teachers have been increased from 25 to 60 per cent.

AT its last meeting the Yale corporation elected Dr. Milton Charles Winternitz dean of the Yale School of Medicine to succeed Dr. George Blumer. Dr. Winternitz joined the Yale faculty in the fall of 1917 as professor of pathology.

AT Washington and Lee University, L. J. Desha, Ph.D., formerly professor of chemistry in the Medical College of Tennessee, has been elected professor of chemistry; W. D. Hoyt, Ph.D., associate professor of biology, has been promoted to professor of biology and head of the department.

AT Oberlin College Associate Professor W. D. Cairns has been promoted to be professor of mathematics and head of the department, professor F. Anderegg having retired after thirty-three years of teaching in Oberlin.

At Princeton University, William Lauder Jones has been appointed professor of organic chemistry. Charles Rogers, of the Museum of Natural History, has been appointed curator of the biological museum. Charles Jones Browne, head of the department of hygiene and physical education at the University of North Carolina, has been appointed to be an assistant professor in that department. James Alexander, on leave of absence for war service, has been made an assistant professor of mathematics. Professor Raymond Smith Dugan was promoted to a professorship of astronomy. Dr. Carl C. Brigham was appointed assistant professor of psychology, and Benjamin F. Howell was raised to the rank of assistant professor of geology.

At the Carnegie Institute of Technology Henry L. Moore, assistant professor of physics at the Mississippi Agricultural College, will be assistant professor of physics, Ruth E. Canfield, instructor of ceramics at Alfred University, instructor of ceramics and weaving. James R. Everett, assistant professor of mathematics at Baker University, and George W. Hess, professor of mathematics at Bethany College, will become instructors in mathematics.

Professor J. T. Wilson, professor of anatomy in the University of Sydney, has been elected to the chair of anatomy at Cambridge, rendered vacant by the death of Professor Alexander Macalister.

DISCUSSION AND CORRESPONDENCE

THE USE OF THE TERM FOSSIL

There is probably no word more widely and loosely used by geologists than *fossil*. Paleontology, the study of ancient life, is literally the study of fossils; and stratigraphy, or the correlation of formations, is principally dependent upon fossils as horizon markers. The broad subject of historical geology, or the evolution of the earth and its organisms, is also largely a study of fossils. All workers in the above mentioned divisions of earth science would define a fossil as the evidence of former life, no matter how much they might disagree as to the full and exact definition of the term. Unfortunately, however, the term is often used by geologists in general as an adjective to denote age of geologic magnitude; hence: "fossil volcano," "fossil river channel," "fossil sand dunes," etc.; all of which objects are obviously of inorganic origin.

Fossil is derived from the Latin, *fossilis*, "dug up or dug out." The latest edition of the Century Dictionary defines the term as follows:

> Any rock or mineral, or any mineral substance, whether of an organic or inorganic nature, dug out of the ground. Specifically, in later geological and mineralogical use, anything that has been buried by natural causes, or geologic agencies, and bears in its form or chemical composition the evidence that it is of organic origin.

In spite of the above, there are literary persons who use the adjective form of the word in the sense of ancient or out-of-date; *i. e.*, "fossil poetry," "fossil statesman." Sometimes the "bad use" of the word is merely ludicrous, as in the case of a paleobotanist who frequently refers in the text to the student of fossil plants as a "fossil botanist."

In the latest text-book of paleontology[1] a fossil is defined thus: "A fossil is the remains of a plant or animal, or the record of its presence, preserved in the rocks of the earth."

A definition more exact than any to be found in the modern text books is proposed as follows: *A fossil is an object which indicates former existence of an organism which has been buried and preserved by geological causes, previous to historic time.* According to this definition the mastodon preserved in the arctic ice is a fossil; the leaf buried in the gutter is not. The remains of an organism may be a true petrifaction and yet not be a fossil. Fossil and petrification are not synonymous. Simply because a species has become extinct does not make it a fossil, even if its remains are petrified, or the knowledge

[1] "An Introduction to the Study of Fossils," H. W. Shimer, Macmillan Co., 1914.

of its former existence is preserved to us by means of impressions, molds or casts. On the other hand, certain shells preserved in the Pre-Pleistocene formations and which are not only practically unaltered but also have living representatives, are true fossils. The element of time as here applied to the definition may seem to certain biologists and geologists to be unessential. It is necessary, however, to have some term which may be applied to the "medals of creation" to set them apart from the realm of organisms which are living, or have lived within historic time.

Fossils may be briefly classified as follows:

A. Direct evidence.
1. Actual remains (spore cases; Oligocene ants, etc.).
   (*a*) Hard and soft parts preserved.
   (*b*) Hard parts only preserved.
   (*c*) Hard parts minus organic matter.
   (*d*) Hard parts plus mineral salts grading into:
2. Minute replacements (coal balls; labyrinthodont, teeth, etc.).
   Replacement molecule by molecule of the original organic matter by mineral salts, resulting in petrifaction which may or may not show structure. Results of metasomatic processes.
3. Coarse replacements (bulk of Palezoic fossils).
   (*a*) Molds of the exterior and interior.
   (*b*) Casts of the exterior and intermediate structures.
4. Prints (leaves; jelly fish, etc.). Plus or minus organic matter in the case of plants.

B. Indirect evidence.
1. Coprolites.
   (*a*) Whole or part of original substance.
   (*b*) Casts of original substance (coprolites of dinosaurs).
2. Artifacts (ant hills; prehistoric flints, etc.).
3. Tracks, trails or burrows (Arthrophycus; dinosaur tracks, etc.).

We may smile when the novelist uses the adjective, *fossil,* in a broad way; we may even argue with the petrologist, or physiographer when he uses the term to describe inorganic phenomena, but what are we to do when the paleontologist speaks of "fossil ripple-mark"? Clearly the word is rapidly becoming so used that it will soon be useless in a scientific sense. Since the paleontologist is more interested in fossils than the petrographer, geographer or even the "general" geologist, and since he alone has defined what fossils are, is it too much for him to ask his brother geologists to either adopt his definition or else to coin a new term which will better express the antiquity of inorganic structures. Perhaps it would be well for the paleontologists to set an example in the "good use" of the term, by using it correctly themselves. As they are also vitally interested in the geologic time-table, perhaps it would not be out of place for them to suggest that Paleozoic, Mesozoic, or Tertiary prefixed to "ripple-mark" or volcanoes would be much more descriptive and accurate than the adjective *fossil.*

RICHARD M. FIELD
DEPARTMENT OF GEOLOGY,
BROWN UNIVERSITY

THE FIXATION OF ATMOSPHERIC NITROGEN

TO THE EDITOR OF SCIENCE: Allow me through the columns of SCIENCE to give publicity to a most unique experiment related to me by the late Dr. Paul Heroult, the inventor of the electric steel furnace, and simultaneously with Hall of the electrolytic process for the isolation of aluminum.

It serves to show in a simple but striking way the "fixation of atmospheric nitrogen" of which we have heard so much in the past four years.

Although described and shown to many scientific friends it was new to them all, and as it lends itself to lecture demonstration deserves to be better known.

The experiment consists in thoroughly mixing 90 grams of fine aluminum powder with 10 grams of lamp-black. This mixture is

poured on a tile or an iron plate making a cone. A piece of magnesium tape, about 5 centimeters long, has one end thrust into the top of the cone, the other end being bent down so that it is easily lighted by the flame of a match.

Contrary to expectation there is no violent puff or explosion, as with magnesium powder, but a steady progressive combustion, vivid and brilliant, emitting little smoke. When the whole has burned down there remains the most beautiful mass of crystals of aluminium nitride, Al_2N_2, mixed with some crystals of aluminium oxide.

The greater part of the air which took part in the combustion is thus solidified, only the small amount supporting the combustion of the carbon going off as gases.

When this nitride is heated with a solution of sodium hydrate ammonia gas is evolved.

When the ammonia is mixed with oxygen or air and passed through heated platinum gauze, nitric acid is produced.

When the ammonia and nitric acid are made to react on each other the valuable fertilizer ammonium nitrate results. When this ammonium nitrate is mixed with aluminium powder a very safe but powerful explosive, "Ammonal" is produced.

Thus we learn how intimately these chemical reactions are related in peace to fertilization, and in war to destruction. The experiment illustrates: Combustion in which the nitrogen of the air, as well as the oxygen acts as a supporter of combustion; the production of a crystalline nitride, Al_2N_2; synthesis of ammonia; synthesis of nitric acid; fixation of nitrogen to serve as fertilizer; fixation of nitrogen to serve as explosive. It would be unwise for us to conclude that explosives serve only in war. Far from it. Man's best and most serviceable feats in engineering have been made with the aid of these powerful agents. We should not forget how seven acres of rock under Hell Gate were blown to bits by one blast, and our harbor opened up to vessels of greater size.

Charles A. Doremus

CURRENT RESEARCH AND PUBLICATION IN THE AMERICAN MUSEUM[1]

In cooperation with the United States National Museum and other museums, North America from the Arctic to the Isthmus is now well covered by American Museum activities. Its work includes explorations, publications and photographic collections, relating to historic and prehistoric races of men, to the insects, fishes, amphibians, reptiles, birds and mammals, as well as to the extinct ancestors of these living groups. Especially noteworthy serial publications on recent explorations, completed or well advanced, are papers on the "Anthropology of the Southwest" with the Archer M. Huntington Fund, the "Bibliography of Fishes" with the Jesup Fund, continued by Professors Dean and Gudger, and six volumes on "Fossil Vertebrates" with the Jesup Fund. Aided by the Jesup Fund, Professor Osborn, as a member of the staff of the United States Geological Survey, has just completed his monograph, "Titanotheres of Western America," on which he has been engaged for nineteen and a half years.

About $75,000 has been expended since 1910 on South American exploration and publication through successive expeditions led by Chapman, Roosevelt, Cherrie, Miller and Richardson. The senior curator, Dr. J. A. Allen, has produced a series of standard papers on South American mammals. Expeditions into the interior bear the name of Theodore Roosevelt. Dr. Chapman's "Distribution of Bird-Life in Columbia," recently awarded the Daniel Giraud Elliot Medal by the National Academy of Sciences, is a classic and leads to similar volumes on the birds of Ecuador, of Peru and of Chile.

The Museum has thus far expended $190,000 on African exploration, research and publication. Unrivaled collections of reptiles, birds and mammals are in storage awaiting the construction of the African Hall, as the result of the untiring field work of a suc-

[1] Modified from the fifty-first annual report of the president, Henry Fairfield Osborn, May, 1920.

cession of explorers, namely, Roosevelt, Tjäder, Akeley, Rainsford, Barnes, Rainey, Lang and Chapin. The two last named have rendered monumental service to African natural history in bringing out the most complete and the most perfectly preserved collection which has ever come from Africa, with precise field notes and 9,500 photographs. The results are being issued in a series of twelve volumes entitled "The Zoology of the Belgian Congo." To these volumes many other specialists of the country are contributing, notably Director W. J. Holland, of the Carnegie Museum, Professor William Morton Wheeler, of Harvard University, and Dr. Henry A. Pilsbry, of the Academy of Natural Sciences of Philadelphia. The first two Congo volumes were recently presented to the King of the Belgians following his visit to the Museum. A duplicate collection of Congo types is being sent to the great Congo Museum at Tervuren, Belgium, according to the agreement of the Museum with the Belgian government.

Through the successive journeys of Mr. Roy C. Andrews in Japan, Korea, the Provinces of Yunnan, Fukien, Shansi, and in Mongolia, aided by the Rev. Harry R. Caldwell, the Museum has made a notable beginning in the collections representing the eastern mountain, plain and desert life in Asia. Examples of the life of tropical Asia and Indo-Malaya are still required. All together there has been expended $35,000 in Asiatic exploration and publication up to the present time.

Popular scientific works are carrying the work of the Museum to readers all over the world. The series of popular volumes by Peary, Stefánsson, MacMillan, Roosevelt, Chapman, Miller, Wissler, Andrews and Lutz constitutes a library of standard reference on Arctic exploration, on African, Asiatic and South American travel, and on the ancient and recent history of the primitive races of Europe and of North America. Among these volumes are the following:

Peary, Robert E.
Northward Over the Great Ice, 1898.
The North Pole, 1910.
Secrets of Polar Travel, 1917.
Stefánsson, Vilhjalmur
My Life with the Eskimo, 1913.
MacMillan, Donald B.
Four Years in the White North, 1918.
Roosevelt, Theodore
Through the Brazilian Wilderness, 1914.
Chapman, Frank M.
Bird Studies with a Camera, 1898.
Camps and Cruises of an Ornithologist, 1908.
Handbook of Birds of Eastern North America, 1912.
The Travels of Birds, 1916.
Our Winter Birds, 1918.
Miller, Leo F.
In the Wilds of South America, 1918.
Wissler, Clark
North American Indians of the Plains, 1912.
The American Indian, 1917.
Andrews, Roy C.
Whale Hunting with Gun and Camera, 1916.
Camps and Trails in China, 1918.
Lutz, Frank E.
Field Book of Insects, 1918.
Osborn, Henry Fairfield
The Age of Mammals, 1910.
The Origin and Evolution of Life, 1917.

For publication as well as for the enrichment of the collections and the preparation of exhibitions, the total sum of $1,412,839.32 has been expended, since Mr. Jesup's decease in 1908, from the income from the Morris K. Jesup Fund, which by the terms of the will is devoted to purely scientific purposes. The research product of the Museum has grown accordingly; the volume of publications has increased several fold; the popular publications, based on the pure researches of their authors, have spread the educational influence of the Museum all over the world. It is interesting to observe that certain branches of science relinquished by many of our universities are taken up by our museums.

The sales of popular publications have reflected the character of the public attendance and interest, being greater than ever, particularly of the *Guide*, which was exhausted much sooner than expected and "out of print" for four months. All together there were sold at the attendants' desks 3,005

Guides, 1,886 *Handbooks,* 3,087 *Leaflets* and 1,044 *Reprints,* a total of 9,022 copies.

The publications of The American Museum of Natural History for the current year include the *Annual Report;* the *Bulletin;* the *Anthropological Papers; Natural History,* the Journal of The American Museum of Natural History; the *Guide Leaflets,* and the *Handbooks.* During 1919 Volume XLI. of the *Bulletin* was published, which contained three articles on mammalogy, one on ichthyology, nine on invertebrate zoology, three on vertebrate palæontology, two on herpetology, one on ornithology and one on invertebrate palæontology. Also two volumes relating to the Belgian Congo were published: Volume XXXIX., containing a monograph by Bequaert on "A Revision of the Vespidæ of the Belgian Congo" and a monograph by Schmidt on "Contributions to the Herpetology of the Belgian Congo"; and Volume XI., which is devoted entirely to Pilsbry's paper on "A Review of the Land Mollusks of the Belgian Congo." The collection of papers on the Belgian Congo has steadily increased; a "List of Reports on the Results of The American Museum Congo Expediton" published this year contains a short description of fifteen such papers.

For the most part the members of the anthropological staff gave their time to the data obtained on former field expeditions. Problems of racial distinction and origins were developed by Assistant Curator Sullivan and Dr. Bruno Oetteking. Mr. Sullivan, with the cooperation of the department of physiology, made a series of microphotographs of racial hair cuttings for study and exhibition. His main investigation, however, concerned itself with a series of measurements upon full and mixed-blood Indians made some years ago under the direction of Professor Franz Boas. These data have been thoroughly compiled and correlated to show the results of race mixture. Among some of the significant conclusions are the constancy of degrees of correlation between bodily proportions even in mixed-bloods and the apparent inheritance of specific correlations between face width and breadth of head. Dr. Oetteking completed the measurement and description of the skulls for northeastern America and eastern Siberia, for a report upon the physical anthropology of the Jesup North Pacific Expedition.

Facilities for promoting research in human biology have been greatly improved during the year. A room adjoining the physiological laboratory has been equipped as an anthropometric laboratory and office for Assistant Curator Sullivan. By special arrangement the equipment of the physiological laboratory is now available for the work of this department. The Galton Society has organized a special laboratory for the study of racial characters, which, for the present, is housed in this department, the curator being the chairman of its governing committee and Assistant Curator Sullivan its director.

Assistant Curator Spinden discovered a correlation between the calendars of the Aztec and Maya that promises to give an unbroken historical record for the New World from the beginning of the Christian era. Mr. Leslie Spier has completed an exhaustive study of the sun dance of the Plains Indians, revealing some interesting culture movements among these tribes. Dr. Elsie Clews Parsons has nearly completed a detailed analysis of the social organization of the Rio Grande Pueblo Indians.

The *Anthropological Papers* deal entirely with the work of the department of anthropology. These papers are now in their twenty-ninth volume. The nine parts which appeared during 1919 include articles on various phases of the history of the Crow, Aztec, White Mountain Apache, Eskimo and Philippine tribes, and make a total of 713 pages, 125 text-figures and 3 maps. Among these articles are "Kinship in the Philippines," by A. L. Kroeber, Vol. XIX., Part III.; "Myths and Tales from the White Mountain Apache," by P. E. Goddard, Vol. XXIV., Part II.; and "The Aztec Ruin," by Earl H. Morris, Vol. XXVI., Part I. An important *Guide Leaflet* on "Indian Beadwork" was prepared by Dr. Wissler. The *Handbook* on the "Peoples of the Philippines," by A. L. Kroeber, has just

appeared. It gives an interesting account of the ethnology and culture of the peoples of these islands.

HENRY FAIRFIELD OSBORN

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE EFFECT OF SNOW UPON THE GROWTH OF WINTER WHEAT

IT has long been believed that a snow cover is a beneficial factor in the growth of winter wheat; but some doubt has recently been cast upon this view, at least with respect to Ohio and Illinois, for which the question has been studied. Two short papers, one by Mr. Clarence J. Root[1] and the other by Professor J. Warren Smith,[2] have served as introductory to a longer discussion by Mr. T. A. Blair.[3] Professor Smith draws a clear distinction between the quantity of snowfall with its subsequent effect and the effect of a snow covering, for it may well be that a very heavy snow will melt quickly and leave the ground bare for a considerable time, or that a very light snow will remain for a long time unmelted on the ground. Thus, the question of the relation of snow and winter wheat is divided into two distinct aspects.

The first aspect has been discussed by Mr. Blair. His method of treating the problem is two-fold: first, by the well-known method of partial correlation, and second, by expressing the yield in linear regression equations of the form $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots$, in which Y is the yield; x_1, x_2, x_3, . . . are the various weather elements, such as mean temperature, total precipitation, sunshine, etc.; and b_1, b_2, b_3, . . . are constants for a given equation depending upon the data. In expressing such relationships, the author has had to assume that there is a linear relation between the weather and yield, which, as he says, "is doubtful in cases of extreme weather conditions," and also that the most important weather influences have been included in his equations. Of the latter, perhaps the most important are temperature and precipitation, although there are many other factors which are not considered owing to lack of data, but which are more or less directly related to the weather, namely, hessian fly and other insects, severe storms, hail, and loss of crop by storm after it is cut.

Taking the state of Ohio as a whole, Mr. Blair finds that there is little evidence that there are monthly values of weather elements which exert a profound influence upon the yield of wheat. After obtaining this negative result, he proceeds to treat smaller areas of the state and shorter periods than the month. First, confining his area to Fulton county, and his period to 10 days, he finds that there are certain conditions of temperature and precipitation—the former more than the latter—operative over short periods, and these are the dominant factors in determining the final yield.

His conclusions, which seem to cast doubt upon the validity of the practise of the Bureau of Crop Estimates in publishing crop estimates as early as December 1, show that for the state as a whole, a warm March and June and a cool, dry May are favorable for a high yield. There are certain critical stages in the development of the plant, in which the conditions during certain 10-day periods may exert an important influence, especially in northern Ohio. It is found that the weather should be cool during the jointing stage, dry during the development of the boot, warm while the head is filling, and warm during the last ten days of stooling. As to the quantity of snowfall, it appears that a heavy fall of snow in March is detrimental. Forecasts of yield, earlier than May or June, believes Mr. Blair, can be of little value, because of the great influence of temperature during those months.

The second aspect of the distinction drawn by Professor Smith, was investigated by Mr.

[1] "The Relation of Snowfall to the Yield of Winter Wheat," *Mo. Weather Rev.*, October, 1919, Vol. 47: 700, 4 figs.

[2] "The Effect of Snow on Winter Wheat in Ohio," *ibid.*, pp. 701–702, fig.

[3] "A Statistical Study of Weather Factors Affecting the Yield of Winter Wheat in Ohio," *ibid.*, December, 1919, Vol. 47: 841–847, 2 figs.

Root in Illinois. He attempted to correlate the number of days with snow on the ground between December and March inclusive, or the number of days in March with freezing weather while the ground was bare, or even the number of days throughout the whole winter when the temperature was below 20° F. with the ground bare, with the yield of wheat in central Illinois, and in every case, he obtained a correlation coefficient so small as to cast great doubt upon the importance of the snow cover in determining the yield of wheat. More specifically, he found that there is reason to believe that wheat has a better prospect when the ground is not covered in January. The best years have been those with less than normal snowfall and with the temperature above normal for the winter. The years of poorest yield were those in which the winters had heavy snow and the temperatures were below normal. The companionship of warm winters and subnormal snowfall, and of cold winters and above-normal snowfall, is doubtless attributable to the fact that in a warm winter much of the precipitation falls as rain and that a snow cover tends to lower surface temperatures.

Studies of this type are important. It is true, however, that they are, through the complexity of weather factors and the pitfalls of the correlation coefficient, not always final in their result. Nevertheless, each serves a useful purpose in drawing the attention of agriculturists and others to the possibilities of relations or aspects of a subject which are either new or are opposed, as in this case, by a less scientific belief.

C. LeRoy Meisinger

SPECIAL ARTICLES

TRANSFERENCE OF NEMATODES (MONONCHS) FROM PLACE TO PLACE FOR ECONOMIC PURPOSES

Speaking generally, it is now beyond question that many soil-inhabiting mononchs feed more particularly on other nemas. However, they never follow these latter into plant roots, except in the case of open root cavities fairly readily accessible. They do not enter living plant tissues in pursuit of their prey. It follows that the good they do is in devouring the larvæ and young of injurious nemas at such times as the latter are accessible either in the soil or in open cavaties in the roots of plants.

In transferring mononchs from place to place with a view to making use of them in combating injurious nemas, the first requisite is a supply of mononchs. Such a supply may be obtained from soils in which the mononchs are numerous, and although we have comparatively little experience to guide us, yet it is now demonstrated that supplies of mononchs existing under these conditions are available. Thus far these supplies have been discovered more or less by accident; the cases, however, are numerous enough to establish the belief that special search will lead to the discovery of a sufficient number of these original sources of mononchs to furnish an adequate supply for trial.

The methods of collecting the mononchs, and transferring them, once they have been found, have been sufficiently elaborated for practical purposes, and published.

In transferring the mononchs to new situations, it is of course best to pay careful attention to the relative physical and biological conditions of the two habitats—the soil from which they are transferred and that to which they are transferred. The physical and biological conditions of the two habitats should be such as to insure the persistence of the mononchs after they have been transferred from the old to the new habitat. If the climatic and soil conditions of the new habitat closely resemble those of the old habitat, there is every reason to suppose that the mononchs will survive and flourish if there is a supply of suitable food.

The practical details may be illustrated by a hypothetical example. Suppose a region in Holland having a sandy soil has distributed in it as a plant pest the devastating nema, *Tylenchus dipsaci*, which, though more or less prevalent, is not doing very serious damage because held in check by mononchs. Suppose the existence of another region, like that in

the vicinity of Bellingham, State of Washington, U. S. A., having a soil and climate similar to that of the district in Holland just mentioned, and suffering more or less severely from the ravages of *Tylenchus dipsaci* because this nema is not sufficiently held in check by any natural force. We may suppose that in this latter case *dipsaci* has been introduced at Bellingham without the enemies and parasites that hold it in check in the first-mentioned place. The mononchs found in the soil of the Holland district feeding upon *Tylenchus dipsaci* are collected and transported to Bellingham and introduced into the soil. There is good reason to suppose that under the new conditions, finding their food abundant, including the larvæ and young of *Tylenchus dipsaci*, the mononchs will flourish *Tylenchus dipsaci* in check.

If it be asked why injurious nemas are transferred from place to place without their enemies being transferred at the same time, the answer is that nemas injurious to plants are often transferred in the interior parts of plants imported in a living condition, and, as already indicated, the mononchs and other predatory nemas are less common in these situations than they are in the adjacent soil, which latter in the course of commerce often is removed from the roots and not shipped. One need only instance the case of bulbs and similar importations to see how much better chance the injurious parasitic nemas have of being imported than have those nemas which feed upon them. There is also reason to believe that sometimes the parasitic nemas infesting crops are more resistant to untoward conditions, *e. g.*, dryness, than are the predaceous nemas.

We have at the present time arrived at a stage where logically the next step is to try out the introduction of promising species of mononchs. Efforts of this kind will necessarily be somewhat expensive, probably more expensive than the corresponding early efforts to introduce beneficial insects. There can be no doubt, however, that the enormous losses due to plant-infesting nemas fully justify the expenditure of even large sums of money in an effort to apply this remedy, more particularly because the remedy, when successful, bids fair to be permanent and self-sustaining.

After long-continued and intensive studies I am thoroughly convinced that many of the practises evolved in the transfer of beneficial insects can, with appropriate modification, be applied to the nemas. At the present time the greatest drawback in the case of the nemas is the small number of people who are technically competent to make the necessary biological examinations. It is in this respect principally that their introduction will differ from that of the introduction of useful insects, for the nema problem is essentially a microscopic one. Though the collection of the nemas from the soil differs entirely from the collection of beneficial insects, the methods have already been brought to such a state that there are no insuperable obstacles.

The percentage of mononchs in miscellaneous collections of soil-inhabiting nemas taken from various situations is roughly indicated by the following figures based on the writer's examinations—in each case of from one thousand to several thousand specimens:

1. Miscellaneous collection from very small quantity of soil taken from the roots of 14 species of plants imported from Brazil, 6.5 per cent. mononchs.
2. Sandy soil about the roots of astilbe and peony, Holland, 11.6 per cent. mononchs.
3. Soil from cornfield in New Jersey in autumn, the prevailing genus was *Mononchus*.
4. Sand from Washington filter beds, 96 per cent. mononchs.

N. A. COBB
U. S. DEPARTMENT OF AGRICULTURE

THE INTERACTION OF ETHYLENE AND SULPHURYL CHLORIDE

SOME time ago,[1] while treating suphuryl chloride (SO_2Cl_2) with ethylene gas (C_2H_4) at room temperature, the writer discovered a reaction quite different from any other which has come under his observation. It was noted that when a fairly strong, steady stream

[1] First observed on February 28, 1918.

of ethylene is passed into sulphuryl chloride at room temperature no apparent change occurs until the gas has bubbled through for quite a long while. Under certain conditions, however, the colorless liquid suddenly turns greenish-yellow, accompanied by rather a sharp rise in temperature, which during the first two or three hours of the run amounts on the average to approximately 10° C. As the temperature rises, the liquid loses its color, soon to be followed by a gradual fall in temperature, which in the course of a few minutes reaches approximately that of the room. When the gas is passed steadily through the liquid, this remarkable cycle returns again and again uniformly and continually in the same order. At the minimum temperature the liquid invariably turns greenish-yellow (about the color of chlorine), which is a sure signal that the temperature will rise. At the maximum temperature, which is usually in the neighborhood of 35° to 40°, the liquid is colorless. A complete cycle ordinarily requires from 10 to 20 minutes, depending upon conditions, and these cycles may be observed for several hours. In the course of time, however, the cycles become longer and the differences in temperature less pronounced. This is what one would expect. A number of different runs has been made, with the same general results. The accompanying diagram shows very clearly some of the cycles observed when one of the experiments was carried out. An explanation of this interesting phenomenon has not been fully worked out, but the mechanism of the reaction is under investigation. It appears that sulphur dioxide and ethylene chloride (Dutch liquid) are among the products of the reaction. It may be that ethylene and sulphuryl chloride first unite to form an unstable compound which then dissociates into ethylene chloride and sulphur dioxide, or it may be that these products are formed by the interaction of the factors as represented by the following chemical equation:

$$SO_2Cl_2 + C_2H_4 \rightarrow C_2H_4Cl_2 + SO_2$$

William Foster

Princeton University

THE AMERICAN PHILOSOPHICAL SOCIETY. IV

SATURDAY, APRIL 24

Afternoon Session—2 o'clock

William B. Scott, D.Sc., LL.D., president, in the chair

Presentation of a portrait of the late Edward C. Pickering, LL.D., vice-president of the society, 1909–1917, by Vice-president Hale.

Animal luminescence and stimulation: E. Newton Harvey, Ph.D., professor of physiology, Princeton University. (Introduced by Dr. H. H. Donaldson.) The production of light by animals is due to the burning or oxidation of a substance called luciferin in the presence of an enzyme or catalyst called luciferase. It resembles the ordinary artificial methods of illumination by burning in that oxygen is as necessary for animal luminescence as it is for the light of a lamp or tallow candle. It differs in that water is absolutely essential for the light production and no carbon dioxide or heat is produced—at least no carbon dioxide or heat is produced at all comparable to that formed during the burning of such substances as tallow, either in the form of a candle or as food, to supply heat and energy for the body. Light production by animals differs also from light produced by combustion in that the oxidation product of luciferin, oxyluciferin, can be easily reduced to luciferin, which will again oxidize with light production. The reaction is reversible and appears to be of this nature—luciferin $+ 0 \rightleftarrows$ oxyluciferin $+ H_2O$. The difference between luciferin and oxyluciferin lies probably in this, that the luciferin possesses two atoms of hydrogen which is removed to form H_2O when the luciferin is oxidized. The H_2 must be added to reform luciferin. Whether the reaction goes in one direction or to the other depends, among other things, on the concentration of oxygen and the presence of a reducing agent. In a mixture of luciferin, luciferase, reducing agent and an abundant supply of oxygen, the reaction goes from left to right (with production of light) to an equilibrium. On removal of oxygen the reaction goes in the right to left direction with reformation of luciferin. Thus, while a firefly is flashing, oxyluciferin is produced and between the flashes oxyluciferin is reduced and is now ready to be again oxidized with light production. We may figuratively describe the firefly as a most extraordinary kind of lamp which is able to make its oil from the products of its own combustion. Not only

is it most efficient so far as the radiation (being all light) it produces is concerned but also most economical so far as its chemical processes are concerned. The above reactions can be demonstrated in a test tube with a mixture of oxyluciferin, luciferase and ammonium sulphide. The ammonium sulphide is probably represented in living cells by reducing enzymes or reductases. If such a test-tube is allowed to stand, oxyluciferin is reduced to luciferin which will luminesce only at the surface of the fluid in the test-tube in contact with air. When the tube is agitated so as to dissolve more oxygen of the air the liquid glows throughout. Even a gentle knock or "stimulus" to the tube is sufficient to cause enough oxygen to dissolve to give a momentary flash of light which is strikingly similar to the flash of light given by luminous animals themselves on stimulation. This suggests that when we agitate a luminous animal or when the luminous gland cells of a firefly are stimulated through nerves with the resultant flash of light, in each case the stimulus acts by increasing the permeability of the surface layer of the cells to oxygen. This then upsets an equilibrium involving the luciferin, luciferase, oxyluciferin, oxygen and reductase within the cell, with the production of light and formation of more oxyluciferin. So long as the luminous cell is resting and unstimulated the tendency is for reduction processes to occur and luciferin to be formed. It must be pointed out that not all sorts of stimulation can be explained in this way, as the stimulation of muscles or nerve fibers may take place in the complete absence of oxygen.

The phosphorescence of Renilla: GEORGE H. PARKER, S.D., professor of zoology, Harvard University. The common sea-pansy, *Renilla*, is found in most southern waters and has long been noted for its phosphorescence. It is a dice-shaped colony of polyps whose upper surface is covered with numerous small whitish patches, the phosphorescent organs. During the day *Renilla* can not be excited to phosphoresce, but at night on stimulation it can be made to glow with a beautiful golden green light. The light is produced in wavelike ripples that spread out from the spot stimulated and run over the upper surface of the animal. They travel at a relatively slow rate that agrees with that at which the nervous impulses of the animal travel. Hence it is concluded that the phosphorescence of *Renilla* is under the control of the nerve-net of the animal which apparently pervades the whole colony.

Feeding habits of pseudomyrmine ants: W. M. WHEELER, Ph.D., Sc.D., professor of economic entomology, Bussey Institution, Harvard University, and IRVING W. BAILEY, assistant professor of forestry, Harvard University. In 1918 the senior author described and figured various stages of the larvæ of *Pachysima* and *Viticola*, two genera of Pseudomyrmine ants from the Congo. Except in their earliest stages these larvæ have the ventral portion of the first abdominal segment much swollen and hollowed out as a peculiar pocket, opening just behind the head. The pocket was called the trophothylax (Wheeler, 1920), because the food, in the form of a subspherical or lenticular, usually dark-colored pellet is placed in it by the worker nurses, so that it is within easy reach of the larva's mouth-parts. As early as 1918 the pellet was known to consist of triturated pieces of insects, but subsequent careful analysis shows that the pellet not only in *Pachysima* and *Viticicola* but also in the two other genera of the subfamily, *Tetraponera* and *Pseudomyrma*, is merely the small pellet ("corpuscle enroulé" or "corpuscle de nettoyage" of Janet), which the worker ant first moulds in its own infrabuccal pocket and which consists of the solid food-particles collected by the ant with the strigils of the fore tibiæ from the surfaces of the antennæ and other parts of the body and carried into the infrabuccal pocket after being wiped off by the tongue and maxillæ. Other ants eventually spit out the pellet, which is commonly a moulded, subspherical conglomerate of diverse particles, such as small pieces of insects, fragments of plant-tissue, fungus spores and hyphæ, pollen grains, etc., and cast it away as refuse, but the worker nurses of the Pseudomyrminæ place it as food in the trophothylax of the larva. Even this, however, is not the whole story. Examination of the mouth of the larva reveals a singular, hitherto undescribed organ, evidently used for reducing the food-pellet to such a finely divided state that it can, when acted on by the digestive juices of the stomach, yield a certain amount of nutriment which the worker ant could not extract from it while it was in the infrabuccal pocket. This larval organ, which may be called the trophorhinium, consists of two flat, opposable plates, corresponding to the dorsal and ventral walls of the buccal cavity, each furnished with very fine, parallel, transverse welts or ridges, which, under a high magnification, are seen to be beset with very delicate chitinous projections or spinules. The ventral usually has more numerous rows of these structures than the dorsal surface. The two sur-

faces are evidently rubbed on one another and thus triturate the substance of the food pellet, only small portions of which are ingested at a time from the trophothylax. In all Pseudomyrmine larvæ and in many larvæ of the other subfamilies, except the Dorylinæ and Cerapachyinæ, the trophorhinium is beautifully developed, although in many ants (Ponerinæ) it must be used for comminuting parts of insects given directly to the larvæ by the workers. In its development the trophorhinium bears a strange resemblance to the stridulatory organs of the petiole and postpetiole of many adult ants. It may, in fact, function also as a stridulatory organ, when the food supply is exhausted, and thus apprise the worker nurses of the larva's hunger. Many ant-larvæ, notably those of the Ectatommiine Ponerinæ and of most genera of Formicinæ, also have elaborate but coarser stridulatory surfaces on the mandibles, so that the larva may be able to produce a variety of sounds and therefore communicate to the nurses more than one need or craving.

On correlation of shape and station in fresh water mussels: A. E. Ortmann, Ph.D., Sc.D., curator of invertebrate zoology, Carnegie Museum, Pittsburgh. Various observers have noticed that freshwater mussels differ in shape according to the localities from which they come, and that, generally speaking, flat or compressed shells are found in the smaller streams, more swollen shells in the larger ones. But these observations have been rather vague and indefinite. The present paper is devoted to the demonstration of this fact by careful measurements and their tabulation on the hand of abundant material from a great number of localities, and it has been found, indeed, that for certain species, such a law does exist, according to which more swollen specimens are found downstream, in the larger rivers, more compressed specimens more upstream, and that in the intermediate stretches of a river, these extremes are connected by gradual transitions.

Evolution principles deduced from a study of the even-toed Ungulates, known as Titanotheres: Henry Fairfield Osborn, Sc.D., LL.D., research professor of zoology, Columbia University.

The Astropotheria: William B. Scott, Sc.D., LL.D., professor of geology, Princeton University.

The middle Cambrian beds at Manuels, Newfoundland, and their relations: B. F. Howell, Jr., B.S., instructor in geology, Princeton University. (Introduced by Professor W. B. Scott.) The beds of Middle Cambrian age at Manuels, near St. Johns, southeastern Newfoundland, are part of a once widespread sheet of marine sediments, deposited millions of years ago off the shore of an ancient continent, which probably stretched across what is now the North Atlantic Ocean and for hundreds of thousands of years formed a land bridge between such parts of North America and Europe as were then above the sea. These beds are of special scientific interest because they contain large numbers of unusually well-preserved fossils, which prove that the creatures that swarmed in the waters then covering much of what is now New England, southeastern Canada and southeastern Newfoundland were of practically the same sort as those living in the seas which at the same period washed over many parts of Scandinavia and the British Isles. North America has probably been joined to Europe in this way several times in the geologic past, so that the animals living in the coastal waters could spread from the one hemisphere to the other; but it is seldom that geologists discover such clear evidence of one of these old connections as that which is presented by the Manuels fossils.

The Michigan meteor of November 26, 1919. Also *the glacial anticyclone and the blizzard in relation to the domed surface of continental glaciers:* William H. Hobbs, D.Sc., Ph.D., professor of geology, University of Michigan.

On Saturday evening the annual dinner of the society was held at the Bellevue Stratford Hotel and was largely attended, the following toasts being responded to:

The memory of Franklin: Hon. Oscar S. Straus.

Our universities: Dr. John M. Clarke.

Our sister societies: Dr. Harvey W. Wiley.

The American Philosophical Society: Professor Leslie W. Miller.

Arthur W. Goodspeed

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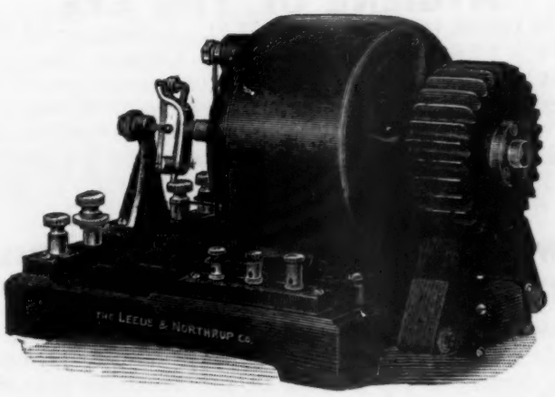

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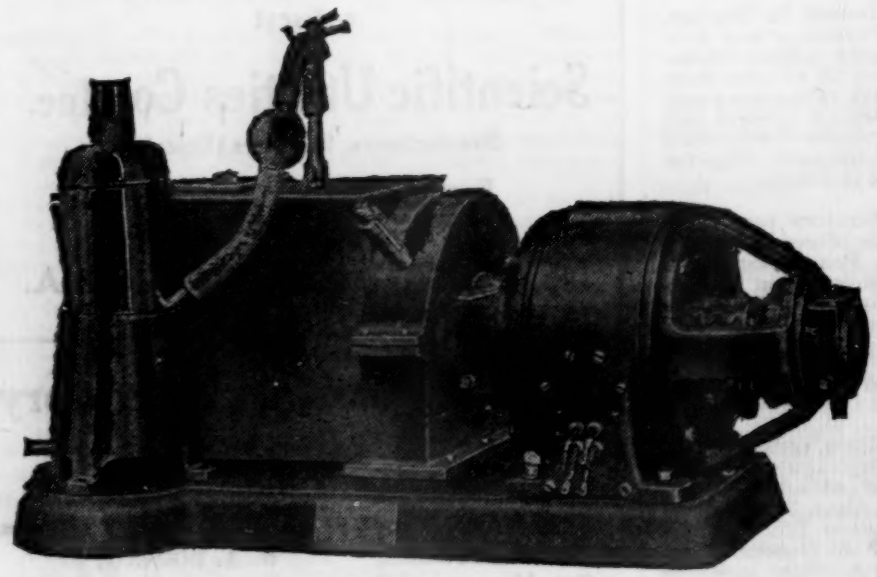

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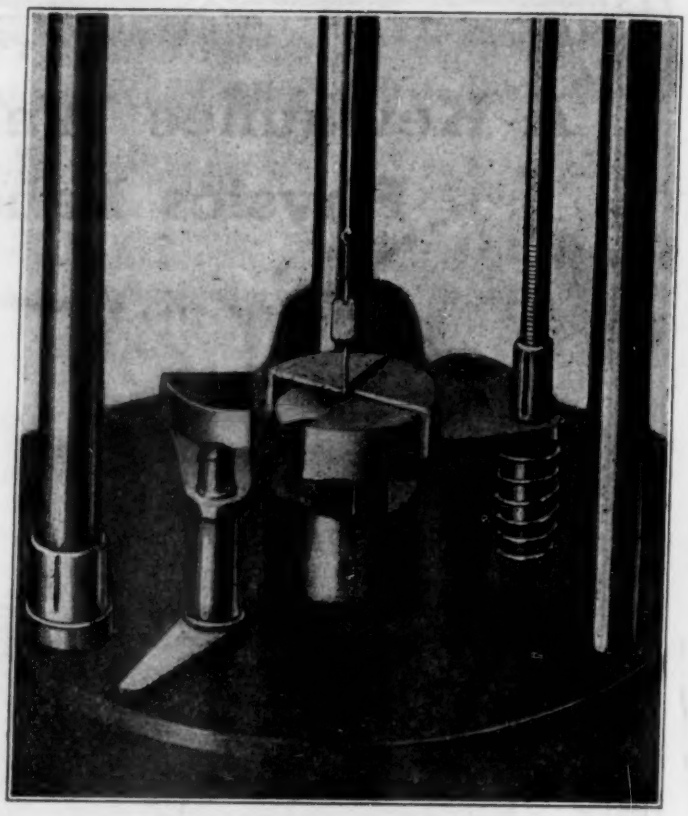

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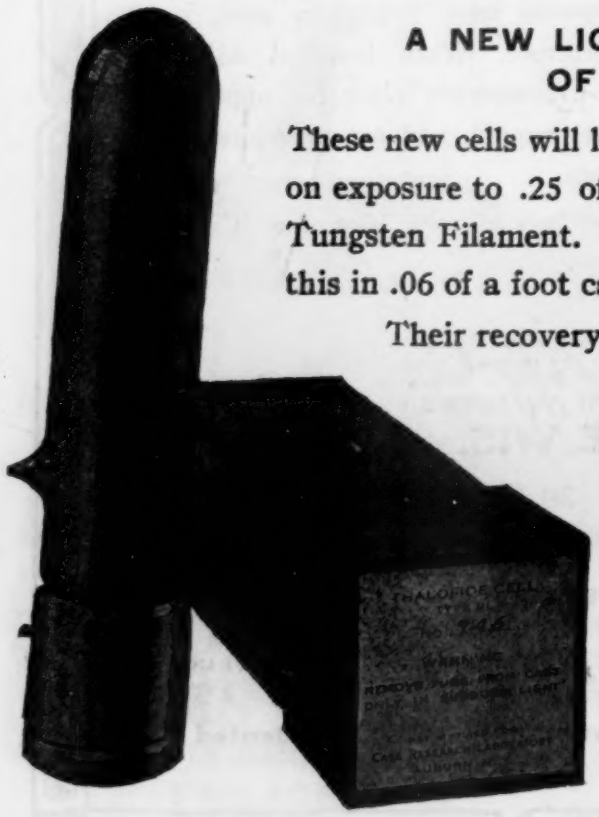

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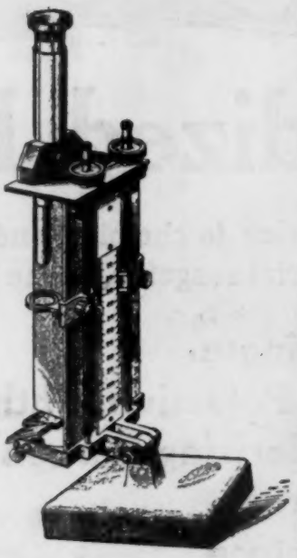

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